

ASSESSING VISITOR “FOSSIL STEWARDSHIP ATTITUDES” TOWARDS NATIONAL PARK SERVICE PALEONTOLOGICAL RESOURCES AND THEIR MANAGEMENT

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Abstract—This study evaluates the human dimensions of paleontological resources through two park-based exploratory visitor surveys undertaken at Badlands National Park, South Dakota, and Denali National Park and Preserve, Alaska. The surveys were designed to collect quantitative data pertaining to visitor values, interests, understandings, motivations, and behaviors associated with fossils from each of these two national parks. The two national parks selected for the visitor surveys are recognized for their globally significant paleontological resources which are of interest to the public, media, and the scientific community. At Badlands National Park 700 visitor surveys were completed, and at Denali National Park and Preserve 477 visitor surveys were completed. The data collected for each park survey were individually evaluated using descriptive statistics and compared with the data from the other respective park’s visitor fossil survey. The concept of “Fossil Stewardship Attitudes” is introduced here to evaluate the visitor attitudes pertaining to specific considerations related to fossils and their management by the National Park Service (NPS).

INTRODUCTION

The application of social science research involving human values, interests, understandings, motivations, and behaviors associated with fossils and paleontological resources is a relatively new focus of study. In 2016, a conceptual framework for assessing the human dimensions of paleontological resources was first introduced by the National Park Service (NPS) and faculty from Penn State University (Santucci, et al., 2016). The collective body of research focused on human relationships with fossils is limited to a handful of published scientific articles and doctoral dissertations.

Here we present two case studies involving exploratory social science surveys undertaken to assess visitor perspectives, referred to collectively as “Fossil Stewardship Attitudes”, related to NPS paleontological resources. The first visitor fossil survey was undertaken at Badlands National Park (BADL), South Dakota, between May and July 2017. The second visitor fossil survey was undertaken at Denali National Park and Preserve (DENA), Alaska, between July and August 2018. Each park was selected for the human-fossil focused surveys based on factors involving the occurrence, distribution, and public access to fossil localities in each park. Both BADL and DENA identify paleontological resources in the parks’ respective Foundation Document as fundamental resources and values (National Park Service, 2014; National Park Service, 2017).

Badlands National Park, South Dakota, preserves one of the richest deposits of Eocene and Oligocene fossil vertebrates from anywhere on Earth. Fossil-rich strata at BADL are exposed throughout most of the approximately 244,000 acre park and are often resources of interest to the approximately one million annual park visitors. Scientific collection of fossils from areas now within the park boundaries dates back to the 1840s, yielding a diverse assemblage of ancient vertebrate fauna. Fossil collecting and research continues to occur at the park under the authority of an NPS-approved research and collecting permit to support science and resource stewardship; however, the park has unfortunately experienced unauthorized and illegal collection of fossils since the monument was established in 1939. The collection, removal, or disturbance of fossils within a national park, without a permit, is prohibited by federal law, regulations, and NPS policies (Paleontological Resources Preservation Act

of 2009, 16 USC §470aaa).

Denali National Park and Preserve, Alaska, also preserves significant paleontological resources which are not as well inventoried or studied from across the more than six million acres of park lands. Over the past two decades the discovery of fossil dinosaur footprints in remote locations and wilderness areas of DENA has received scientific and media attention. DENA still largely remains a trailless park and most visitors access popular areas of the park via shuttle bus. At least currently, this limits visitor access to fossil areas, yet this could change as visitor desires, expectations (particularly related to paleontological resources), and park infrastructure change in the future. Although only a small number of DENA’s nearly 600,000 annual visitors access the remote fossil localities in the park, increased public interest and media attention associated with the fossil dinosaur tracks may lead to more visitors planning backcountry hikes to view these non-renewable fossils.

The two exploratory visitor fossil surveys at BADL and DENA have yielded data and information to better understand some of the human dimensions of paleontological resources observed within each of these national parks. Individually and together, these surveys present preliminary data tied to visitor values, attitudes, and motivations related to park fossils that may influence visitor behaviors involving park fossils during park visits. This information will help increase awareness and inform park managers about visitor perspectives and “Fossil Stewardship Attitudes” pertaining to park paleontological resources. These exploratory visitor fossil surveys also suggest that further research involving the human dimensions of paleontological resources is warranted and should be considered.

HUMAN DIMENSIONS OF PALEONTOLOGICAL RESOURCES: PREVIOUS WORK

The pioneering work introducing the concept of the human dimensions of paleontological resources was presented by Santucci et al. (2016). This conceptual framework outlined the range of human values associated with fossils, which include: scientific, historical, educational, recreational, economic / commercial, personal, spiritual, aesthetic, and other values. Fossils were considered relative to laws, scientific principles, resource management practices, conservation, preservation,

stewardship, commercial interests, and ethics (Santucci et al., 2016).

Fossils have also gained recognition in recent years as “Paleontological Heritage” in discussions of global geologic heritage and geoconservation (Endere and Prado, 2015; Page, 2018; Larwood and Prosser, 2019; Larwood et al., 2022). Important fossil localities from around the world are being protected as national parks and monuments in the United States or designated as World Heritage Sites under UNESCO. The term paleontological heritage fundamentally denotes and conveys the relationships and connections between humans and fossils.

Although not specifically referenced as human dimensions research, only a few social science projects have focused on NPS paleontological resources. During the 1990s, two NPS areas were the focus of social science studies led by researchers at Virginia Polytechnic Institute, to evaluate visitor attitudes and perceptions relative to paleontological resources. The initial study involved a multi-year visitor study undertaken at Petrified Forest National Park (PEFO), Arizona, to better understand visitor behavior associated with the souvenir collecting of petrified wood from localities within the park by visitors (Williams et al., 1993; Widner and Roggenbuck, 2000, 2003). A similar research project was undertaken at Fossil Butte National Monument, Wyoming, during the late 1990s to evaluate visitor attitudes related to fossils considering the active commercial fossil collecting operations surrounding the monument (Hockett and Roggenbuck, 2002, 2003; Hockett, 2008). The results of these studies provided important information to inform NPS managers about how visitors and local residents viewed fossils in and around the NPS-administered lands.

More recently, Kim and Weiler (2013) examined visitors’ attitudes towards fossil collecting by tourists in the Charmouth coastal area in the southwest of England. The Charmouth coastal area is a popular area for avocational fossil collecting, and the research revealed two distinct populations of fossil collectors based on environmental attitudes. The two tourist groups varied in terms of demographic, attitudinal, and behavioral characteristics relative to environmental sensitivity and responsibilities. The analysis revealed that two groups were significantly different in terms of gender, age, and recreational use patterns.

This previous research demonstrates the need for similar fossil-focused social science work on other public lands preserving paleontological resources. The use of visitor fossil surveys has yielded data available for evaluation using basic descriptive statistics to assess “Fossil Stewardship Attitudes” serving as the basis for the two case studies presented here for BADL and DENA.

CASE STUDY BADLANDS NATIONAL PARK

Paleontological resources are identified as part of the “Park Purpose”, “Park Significance”, “Fundamental Resources and Values” and a primary “Interpretive Theme” in the Badlands National Park Foundation Document (2017). The NPS specifically references one of the purposes of BADL is to, “*Preserve, interpret, and provide for scientific study of the paleontological and geological resources of the White River Badlands.*” Two significance statements pertaining to the paleontological resources of BADL are presented in the park’s Foundation Document including: 1) “*The park’s geological and paleontological resources provide insight into climatic history, biological diversity, evolution, and geological processes particular to the boundary between the Eocene and Oligocene epochs, as well as a unique opportunity to trace the evolution of the prairie ecosystems of the Great Plains.*”; and, 2) “*The long history of research in the White River Badlands has contributed greatly to the science of vertebrate paleontology in North America.*” Finally, the Fundamental Resources and Values at BADL are recognized in the following statement, “*The White*

River Badlands preserves one of the most extensive records of the Eocene/Oligocene transition in North America, providing insight into climatic history, biological diversity, and evolution. Badlands National Park manages the largest paleontological museum collection in the National Park Service and is the source of more than 200 type and potential type specimens.”

One of the earliest published reports of fossils from the American west occurred during the 1840s involving western fur traders collecting fossil specimens from the “mauvaises terre” or badlands of the Dakota Territory to transport back east for trade or sale (Prout, 1846). Despite more than 175 years of fossil discovery and study from the fossiliferous strata in and around BADL, new fossil taxa continue to be described and named (Welsh, 2021; Santos et al., 2023; Shreero et al., 2024). The globally significant paleontological resources from BADL attract scientists and park visitors from around the world. The first annual National Fossil Day logo issued in 2010 features a brontothere, one of the iconic fossils from BADL (Fig. 12a). The annual visitation at BADL ranges between 870,000 to over 1.2 million visitors per year; many of whom come to view and learn about the park’s fossils (<https://www.nationalparked.com/badlands/visitation-statistics>). Visitors to BADL have the opportunity to participate in a variety of fossil-focused educational and recreational experiences including: observe naturally occurring fossils within the geologic strata; hike the Fossil Exhibit Trail; view fossil-themed exhibits in the park’s visitor center; observe fossil preparators clean fossils; and, join a ranger for a fossil talk or walk.

In 2017 an exploratory survey of visitors at BADL was undertaken to gather data on several human dimension variables associated with fossils. BADL was selected as the fossil park to undertake a pilot visitor fossil survey based on both the rich interpretive programs for paleontology hosted by the park and the fact that the park has a history of unauthorized fossil collecting by park visitors. The collection of fossils without an NPS-approved research and collecting permit is prohibited by federal laws, regulations, and NPS policy (Paleontological Resources Preservation Act 2009). The rapidly eroding and fossiliferous strata at BADL expose high-quality fossils, sometimes complete and articulated skeletons of ancient mammals and other vertebrates (Fig. 1). These qualities, combined with the widespread geographic occurrence and abundance of the fossils, often result in incidents of unauthorized fossil collecting (theft) within the park.



FIGURE 1. Well preserved fossil skull with teeth of an Oligocene mammal exposed at the surface at Badlands National Park. (NPS Photo)

BADLANDS VISITOR FOSSIL SURVEY

The BADL visitor fossil survey was designed to gather data to help address a series of questions to inform park management about visitor's interests, knowledge, values, understandings, attitudes, motivations, and recreational choices with respect to paleontological resources. The survey questions also seek to identify and better understand "fossil stewardship attitudes" through the evaluation of visitors' responses pertaining to "fossils and their management" in the park. Below are six areas of interest on which we focused this exploratory study to gain a baseline understanding of human dimensions of paleontological resources through the voluntary survey of park visitors at BADL.

- R1: (Demographics) Who are the visitors to Badlands National Park in terms of gender, age, race, education, previous visits to park, group category, group size, and other demographic variables?
- R2: (Awareness and Knowledge) How knowledgeable are park visitors about fossils, and how do they self-report on their knowledge about fossils?
- R3: (Values) What are the park visitors' values associated with fossils?
- R4: (Understanding) How well do visitors understand park rules pertaining to fossils?
- R5: (Fossil Stewardship Attitudes) What attitudes do visitors have regarding the collection of fossils from Badlands National Park?
- R6: (Recreational Choice) What fossil-related activities do visitors participate in during their visit to Badlands National Park?

Visitor fossil surveys were distributed to visitors at four locations in BADL. The survey locations included: outside of the Ben Reifel Visitor Center, Cedar Pass Campground Amphitheater, Fossil Exhibit Trail, and Windows / Door Trail Entrance (Fig. 2). These locations were selected to be inclusive of the variety of recreational and interpretive experiences available throughout the park and represent areas with sufficient visitor use to support the survey.

The study involved the distribution of in-person written questionnaires to visitors at BADL between May 20 and August 10, 2017 (Appendix 1). The survey was intended for adult (18 years or above) participants visiting the park. The survey questions were designed to evaluate the relationships between the visitor demographics, interests, knowledge, values, understanding, fossil stewardship attitudes, and recreational choices pertaining to fossils.

This study sought to determine whether there are any relationships between visitor values or level of knowledge about fossils and the visitor's decision (recreational choices) to participate or not to participate in specific park programs and activities related to the park's fossil resources. Additionally,

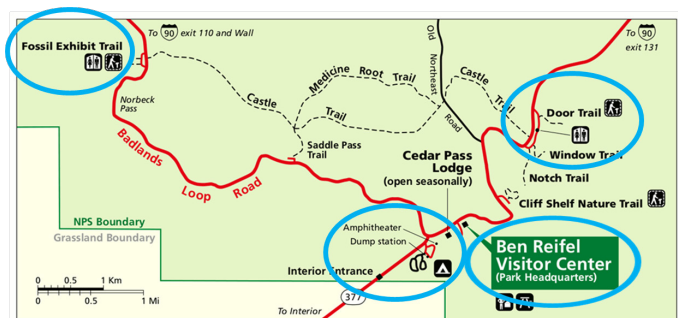


FIGURE 2. Badlands National Park Visitor Fossil Survey locations including: Ben Reifel Visitor Center, Door / Window Trail, Cedar Pass Campground Amphitheater, and Fossil Exhibit Trail. (NPS Map)

the survey sought to determine if there are any relationships between visitor values, knowledge, and interests in fossils and whether visitors engage in behaviors which are appropriate or inappropriate in U.S. national parks. Surveys were distributed to visitors at 4 locations within BADL (Fig. 2). Visitors were welcome to complete the surveys at the site of distribution or to complete the surveys later during their visit to BADL and drop off at one of the four distribution locations in the park.

All individuals participating in the survey did so voluntarily and the identity of all participants is maintained as anonymous. The participants of the survey were not asked to disclose any personal identity information, and therefore the survey will not pose any identity risks to the participants. We did not employ any methods to assess the non-response bias for the BADL visitor survey.

BADL VISITOR FOSSIL SURVEY RESULTS AND EVALUATION

R1: (Demographics) Who are the visitors to Badlands National Park in terms of gender, age, race, education, previous visits to the park, group category, group size, and other demographic variables?

Demographic information was obtained from visitor responses to Questions 9 through 17 in the BADL Visitor Fossil Survey (Appendix 1). A previous visitor demographic survey was conducted at BADL between August 2 – 8, 2000 and a report was published in July 2001 (Simmons and Gramman, 2001). The 2000 survey was distributed to 798 visitors, which resulted in a total of 639 surveys completed or 80.1% response rate. Based on the 2000 BADL survey, 93% of the visitors reported they were U.S. citizens and 7% were international visitors, 65% reported they were first time visitors to BADL, 83% of visitors reported spending less than one day at BADL, 61% of visitors reported they were in family groups, and 50% of the visitors reported they had completed bachelor's degree or higher. The 2000 survey demographic data were used for comparison to the data obtained from the more recent 2017 visitor fossil survey at BADL. Table 1 presents a comparison between the demographic data from the 2000 and 2017 visitor surveys at BADL and exhibits some remarkable similarity.

R2: (Awareness and Knowledge) How knowledgeable are park visitors about fossils and how do they self-report on their knowledge about fossils?

The BADL visitor responses to this question (Question #1 in BADL Visitor Fossil Survey) involved assessing the visitors' awareness and knowledge of the significant resources preserved at BADL. The survey presented eight different significance statements associated with park resources. Five of the significance statements accurately represent the resources at BADL and three are inaccurate statements and do not represent true significance statements associated with the resources at BADL. The survey included a 7-point Likert Scale for this question with a score of 7 indicating the visitor strongly agreed with the significance statement about BADL resources and a score of 1 indicating the visitor strongly disagreed with the significance statement about BADL resources.

The five significance statements which accurately represent the resources at BADL include: "World Renowned Geology", "Prairie Ecosystem", "Native American History", "Important Fossil Localities", and "Home to Buffalo Herd." The three inaccurate significance statements which are not associated with BADL include: "Dinosaur Locality", "Shaped By Ice Age Glaciers", and "First National Park." The results of the survey for this question indicate that most of the visitors are aware and knowledgeable about the significant park resources for BADL and are able to recognize the inaccurate significant statements associated with BADL (Table 2).

TABLE 1. Comparison between the demographic data obtained during two different visitor surveys at BADL undertaken in 2000 and 2017.

	2000 SURVEY	2017 SURVEY
COMPLETED SURVEYS	639	700
VISITORS CONTACTED	798	858
RESPONSE RATE	80.1%	81.6%
AGE (MEAN)	45.5	45.27
AGE BETWEEN 36 - 55	40%	41%
GROUP - ALONE	7%	4.3%
GROUP - FAMILY	61%	67%
GROUP - FRIENDS	20%	14.6%
GROUP SIZE (MEAN)	3.75	3.79
GROUP SIZE = 2	39%	34.1%
EDUCATION = BS and ABOVE	50%	69.2%
% US VISITORS	93%	95.4%
% FOREIGN VISITORS	7%	4.6%
# OF STATES	44	46
# OF FOREIGN COUNTRIES	14	19
FIRST VISIT	65%	68%
PREVIOUS VISITS	35%	32%

However, there is one important observation from the results of the visitor survey which show the mean visitor score for one of the inaccurate significant statements (“Dinosaur Locality”) was slightly higher than the mean visitor score for one of the actual significant statements (“Home to Buffalo Herd”). In other words, the survey results indicate there is a greater belief (although false) that there are dinosaur localities at BADL compared to the awareness that there is a “bison herd” in BADL (which is true). These results reflect a common misunderstanding of the park resources by some park visitors. This misunderstanding by park visitors is something that the experienced BADL park rangers are aware of and is directly related to one of the important interpretive themes for BADL addressed in the park planning documents (NPS 2017; E. Welsh, pers. comm. 2024). The basis for this misunderstanding is simple and tied to the fact that many visitors automatically think “dinosaur” when they hear the word “fossil”. Although BADL is one of the richest fossil localities on Earth, there are no dinosaur fossils in the park. The world-renowned fossils of BADL are primarily a rich assemblage of fossil mammals which existed and preserved as fossils after the extinction of the dinosaurs. The BADL visitor survey provides the first scientific data to confirm what the BADL rangers have long recognized about visitor misunderstanding of BADL fossils. Given the survey results indicating that more visitors incorrectly responded, “there are dinosaurs at BADL” compared to the number of visitors who

TABLE 2. The mean score and percentage for responses to the BADL visitor fossil survey question #1 involving visitor awareness and knowledge of the significant resources preserved at BADL. The BADL significant resources which are accurate are presented in the light green color and the BADL significant resources where are not accurate are presented in orange in the table above.

BADL SIGNIFICANT RESOURCES	MEAN	% SCORE
WORLD RENOWNED GEOLOGY	6.61	94.4
PRAIRIE ECOSYSTEM	6.50	92.9
NATIVE AMERICAN HISTORY	6.26	89.4
IMPORTANT FOSSIL LOCALITIES	6.06	86.6
DINOSAUR LOCALITY	5.47	78.1
HOME TO BUFFALO HERD	5.33	76.1
SHAPED BY ICE AGE GLACIERS	3.55	50.7
FIRST NATIONAL PARK	3.00	42.9

responded they were aware that “modern buffalo inhabit the park”, suggests the park rangers have an opportunity to provide more resource education at BADL (Table 2).

R3: (Values) What are the park visitors’ values associated with fossils?

The BADL visitor responses to this question (Question #4 in BADL Visitor Fossil Survey) involved rating categories of human values associated with fossils. The survey included a 7-point Likert Scale for this question with a score of 7 indicating the highest level of importance assigned to a particular value, and a score of 1 indicating the lowest level of importance assigned to this value. The results of the survey indicated that all the value categories collectively received at least a medium level score, showing that the participants recognized the diverse values associated with fossils. However, both “Scientific” and “Educational” values received the highest mean scores which were greater than 6.5 out of a total 7, or greater than a 95 percent (Table 3).

R4: (Understanding) How well do visitors understand park rules pertaining to fossils?

The BADL visitor responses to this question (Questions #5, 7 and 8 in BADL Visitor Fossil Survey) involving visitor understanding of park rules pertaining to fossils is integrated and discussed below with R5 (Fossil Stewardship Attitudes).

R5: (Fossil Stewardship Attitudes) What attitudes do visitors have regarding the collection of fossils from Badlands National Park?

The BADL visitor responses to R4 (Understanding) question involving visitor understanding of park rules pertaining to fossils is integrated and discussed here with R5 pertaining to the concept of Fossil Stewardship Attitudes (Questions #5, 7 and 8 in BADL Visitor Fossil Survey). Fossil Stewardship Attitudes are beliefs and perspectives that individuals possess towards the management practices associated with fossils as expressed with some degree of favor or disfavor. In the case of questions R5 the focus involves the visitor perspectives related to fossil collecting at BADL.

The visitor surveys used the psychometric Likert scales for responses. For the BADL survey a 7-point Likert scale was used

TABLE 3. The mean score and percentage for responses to the BADL visitor fossil survey question #4 involving human values associated with fossils.

VALUES OF FOSSILS	MEAN	% SCORE
SCIENTIFIC VALUE	6.69	95.6
EDUCATIONAL VALUE	6.66	95.1
AESTHETIC VALUE	5.46	78.0
RECREATIONAL VALUE	5.28	75.4
ENTERTAINMENT VALUE	5.00	71.4
SPIRITUAL VALUE	4.96	70.8
MONETARY OR COMMERCIAL VALUE	4.72	67.4

to score responses where a score of 1 = strongly disagree and a score of 7 = strongly agree. A score of 4 = neutral response. The mean score is based on the mean of all the survey responses; for the BADL survey N = 639 completed surveys. Presented below are 30 Fossil Stewardship Attitudes showing the mean scores and percentages of participants who agreed or disagreed in each attitude. The black row in the middle of the Table 4 below is essentially the inflection point where the questions transition from above and below the neutral zone score of 4.

R6: (Recreational Choice) What fossil-related activities do visitors participate in during their visit to Badlands National Park?

Visitors to BADL are presented with a wide variety of educational and recreational opportunities which are specifically tied to the park's rich paleontological resources. These include both ranger-led and self-guided opportunities to observe, discover, learn about, and understand the fossils preserved in the park. Fossils can be observed throughout a large percentage of the park, and hikes along developed trails or in the backcountry offer the opportunity to discover or view in situ fossils. The park's visitor center hosts fossil-themed exhibits and a fossil preparation lab to view paleontologists working to clean and study fossils (Fig. 3). Park rangers working in the visitor center distribute Junior Paleontologist activity booklets as part of a

TABLE 4. The mean score and percentages of visitors participating in the BADL survey who either agree or disagree with the "Visitor Fossil Attitude" statements included in Questions 5, 7 and 8 in the survey.

FOSSIL STEWARDSHIP ATTITUDES	MEAN	% AGREE	% DISAGREE
UNAUTHORIZED FOSSIL COLLECTION COULD LEAD TO FINE OR OTHER PENALTY	6.45	92.1	7.9
FOSSILS IN PARKS ARE PROTECTED BY LAW	6.41	91.5	8.5
VISITORS SHOULD REPORT FOSSIL DISCOVERIES TO PARK RANGER	6.40	91.5	8.5
VISITOR COLLECTION OF FOSSILS NOT ALLOWED IN PARK	6.29	89.9	10.1
FOSSIL EXCAVATION MUST BE UNDERTAKEN BY PROFESSIONAL TO PRESERVE INFO	6.23	89.0	11.0
VISITORS NOT ALLOWED TO COLLECT FOSSILS FROM PARKS	6.09	87.0	13.0
MAINTAIN SOME FOSSILS IN FIELD FOR OTHER VISITOR'S TO EXPERIENCE	6.01	85.9	14.1
FOSSILS CAN ONLY BE COLLECTED UNDER PERMIT ISSUED BY PARK	5.93	84.7	15.3
FOSSILS ARE NON-RENEWABLE RESOURCES	5.83	83.3	16.7
ANY COLLECTION OF FOSSILS ONLY ALLOWED UNDER A RESEARCH PERMIT	5.81	83.0	17.0
NOT ALL FOSSILS CAN BE COLLECTED & SOME WILL BE LOST TO NATURAL PROCESSES	5.46	78.0	22.0
DECISION FOR FOSSIL COLLECTION SHOULD CONSIDER IMPACTS TO OTHER RESOURCES	5.44	77.7	22.3
RARE FOSSILS MUST BE COLLECTED TO PRESERVE SCIENTIFIC INFO	4.87	70.0	30.0
FOSSILS ARE RARE	4.61	65.9	34.1
VISITORS UNAWARE COLLECTION OF FOSSILS NOT PERMITTED IN PARKS	3.99	57.0	43.0
IF FOSSIL NOT COLLECTED IT WILL BE WEATHERED & DESTROYED	3.64	52.0	48.0
FOSSILS ARE COMMON	3.35	47.9	52.1
UNAUTHORIZED FOSSIL COLLECTION IN PARK MAY RESULT IN "BAD LUCK"	3.09	44.1	55.9
EDUCATION GROUPS ALLOWED TO COLLECT FOR EDUCATION PURPOSES	2.89	41.3	58.7
VISITOR DESIRE TO COLLECT FOSSILS GREATER THAN POTENTIAL RISK OR PENALTY	2.69	38.4	61.6
FOSSILS HAVE MONETARY VALUE & VISITOR MAY NEED MONEY	2.55	36.4	63.6
OKAY TO COLLECT FOSSILS IF USED FOR EDUCATION	2.49	35.6	64.4
IF FOSSIL NOT COLLECTED, SOMEONE ELSE WILL LIKELY COLLECT	2.35	33.6	66.4
ALL FOSSILS MUST BE COLLECTED SINCE NPS ALLOWING FOSSILS TO DISAPPEAR	2.16	30.9	69.1
FOSSILS ARE RENEWABLE RESOURCES	2.05	29.3	70.7
VISITORS ALLOWED TO COLLECT RARE FOSSILS THREATENED BY EROSION	1.86	26.6	73.4
VISITORS ALLOWED TO COLLECT COMMON FOSSILS IN PARKS	1.78	25.4	74.6
COLLECTION OF ONE OR FEW FOSSILS WILL NOT BE NOTICED	1.72	24.6	75.4
FAMILY TRADITION TO COLLECT FOSSILS IN PARK	1.72	24.6	75.4
VISITOR IS FOSSIL EXPERT & KNOWS MORE THAN NPS	1.53	21.8	78.2

resource-specific educational outreach for children. The park bookstore offers many fossil-themed books and souvenirs for visitors to purchase.

Along the park roads and trails are interpretive wayside exhibits which present information about the geology and paleontology of BADL. The Fossil Exhibit Trail is a popular and award-winning trail for visitors to stretch their legs and learn about the park's globally significant fossils. Visitor's to BADL are presented with outstanding recreational choices involving fossils, and the visitor fossil survey grouped these activities into eight categories: 1) view fossils in the visitor's center; 2) attend a ranger program on fossils; 3) see fossils while hiking in the park; 4) view fossils being prepared in the visitor center; 5) collect fossils in the park (which is an unauthorized activity); 6) hike the Fossil Exhibit Trail (Fig. 4); 7) participate in the "Junior Paleontologist" activity; and, 8) purchase fossil-themed books or souvenirs in the park's bookstore.

Given the sampling strategy for the visitor fossil survey, four locations in BADL were used for visitors to participate in the survey (Fig. 2). An equal number of surveys were obtained from all four of the survey locations to capture responses from visitors traveling either east or west on the park road, at different stages in their visit to BADL. Visitors who have not yet visited the visitor center, hiked in the park, or participated in a park ranger led activity, will not have participated in some or all of the visitor fossil activities available within the park. Therefore, the visitor responses to the survey will reflect whether they have just entered the park or have been able to experience the visitor center and other activities (Fig. 5 and 6).

Question #2 in the survey indicates that approximately 59% ($n = 700$) of the survey participants responded "YES" that they have viewed fossils at the visitor center (Fig. 3). This would suggest that approximately 40% or greater of the visitors did not yet experience the BADL visitor center or at least view the exhibits in the visitor center at the time they participated in the visitor fossil survey or they did not visit the visitor center at all. The viewing of fossils at the park's visitor center is the activity with the highest response rate in the survey, suggesting the

importance of highlighting fossil education and outreach at the visitor center. Hiking the "Fossil Exhibit Trail" (42% reporting this activity) and viewing fossil preparation (nearly 38%) in the visitor center were also reported as other fossil-themed activities visitors were participating in. The visitor survey included eight fossil-themed activities for visitors to participate during their visit to BADL. The responses range from visitor participation in zero (0) fossil-themed activities up to a total of eight (8) fossil-themed activities (Fig. 5 and 6).

The visitor fossil survey includes six individuals who responded that they collected a fossil or fossils as an activity they participated during their visit to BADL. The collection of fossils from a National Park Service area such as BADL is prohibited, unless the collecting is undertaken with an approved research and collecting permit. Therefore, if these responses are accurate they reflect instances of unauthorized fossil collection and in violation with NPS laws. One explanation is that these responses were made by individuals who were not accurately reporting, or these individuals honestly reported on this illegal activity of fossil collecting during their visit to BADL. It is important to note that the park has no plans to investigate these survey results with respect to maintaining the anonymity and confidentiality of the participants which is paramount in this type of social science research.

CASE STUDY DENALI NATIONAL PARK

Denali National Park and Preserve (DENA) encompasses over six million acres of Alaskan wilderness landscape preserving tundra, glaciers, mountains, alpine forests, and wildlife. The park's iconic namesake Denali (formerly Mount McKinley) is the tallest peak in North America, reaching an elevation of 6,190 m (20,310 ft). The area was established as a national park on February 26, 1917, and was originally named Mount McKinley National Park in honor of President William McKinley. The park was expanded and renamed DENA in 1980. The discovery of globally significant paleontological resources at DENA has captured the attention of scientists, the public, and media for



FIGURE 3. Paleontology-themed exhibits on display at the Ben Reifel Visitor Center at Badlands National Park. (NPS Photo)



FIGURE 4. The Fossil Exhibit Trail at Badlands National Park offers a fossil-themed interpretive hike for park visitors. (NPS Photo)

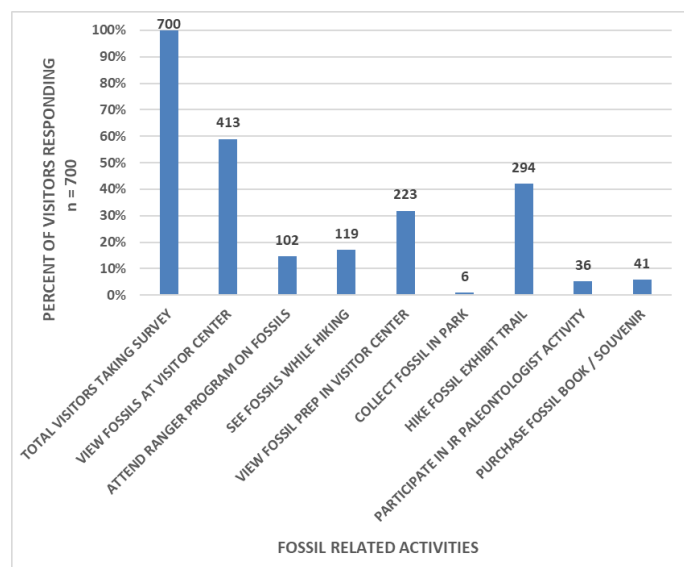


FIGURE 5. The visitor survey responses to BADL Visitor Fossil Survey question #2 pertaining to whether they participated in any of the eight fossil-themed activities during their visit to Badlands National Park. The numbers associated with each activity reflect the number of “YES” responses in the visitor fossil survey for each activity. (n = 700)

more than a decade. Documentation of extensive dinosaur trackways, preserved in backcountry wilderness, has revealed one of the largest fossil track localities in North America.

Both paleontological resources and wilderness are identified as significant and fundamental park resources and values in the Denali National Park and Preserve Foundation document (National Park Service, 2014). Paleontological resources are identified in one of DENA’s significant statements, which

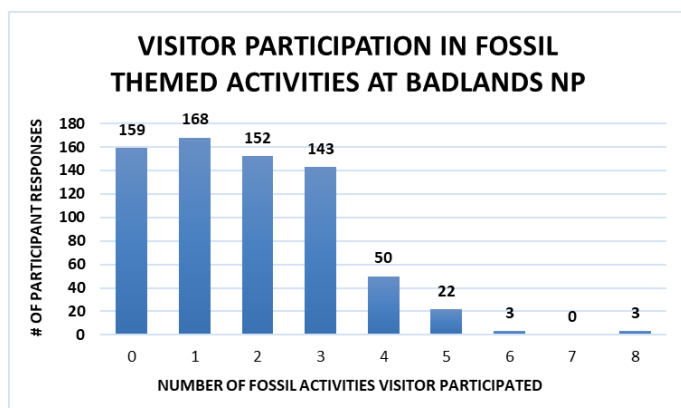


FIGURE 6. The visitor survey responses derived from question #2 pertaining to the number of different fossil themed activities they participated during their visit to Badlands National Park. The responses range from visitor participation in zero (0) fossil-themed activities up to a total of eight (8) fossil-themed activities.

specifically states, “Denali is one of the premier protected areas in North America for understanding the ecological relationships among species and the environment at the end of the Age of Dinosaurs about 70 million years ago. Thousands of trace fossils of dinosaurs and other species have been found in the Cantwell Formation since 2005, when the first dinosaur track was found.”

In 2005, fossil vertebrate footprints, primarily associated with dinosaurs, were discovered in the Cretaceous Cantwell Formation at DENA (Fig. 7). Over the next 15 years, thousands of trace fossils of fish, pterosaurs, dinosaurs (theropods, hadrosaurs, ceratopsians and possibly ankylosaurs), birds, and terrestrial and aquatic invertebrates have been documented at DENA (Fiorillo et al. 2006, 2007, 2011; Santucci et al., 2011). Fossil track localities range from large bedding planes with

thousands of tracks, to single footprints with skin impressions, tail drags, coprolites, and other isolated traces (Brease et al. 2009). A single manus track from DENA was identified as pterosaur representing the first record of a pterosaur from Alaska as well as the northernmost occurrence of pterosaurs (Fiorillo et al. 2009, Fiorillo et al. 2011). A diverse avian ichnofauna is also documented from multiple localities in the Cantwell Formation at DENA (Fiorillo et al. 2011).

The Tattler Creek fossil track locality in DENA is globally significant and preserves thousands of fossil footprints, mostly hadrosaurid, that appears to represent the movement of a multi-generational hadrosaur herd (Fiorillo et al., 2014). Handprints (manus) and footprints (pes) are attributed to a juvenile hadrosaur, providing evidence of facultative quadrupedalism in juvenile hadrosaurs as well as adults (Fiorillo and Tykoski, 2016). Significant unpublished sites are the subject of ongoing study, yielding trackways of ceratopsians and hadrosaurs, as well as various avian and non-avian theropods (Druckenmiller et al., 2017; P. Druckenmiller, personal commun., 2018; Tweet and Santucci, 2018).

The scientific interest and public awareness of the fossil dinosaur tracks at DENA continues to increase as new discoveries are reported in scientific publications, news media, and interpretive exhibits at the park (Fig. 8). DENA dinosaurs and dinosaur footprints are featured in the 2021 National Fossil Day logo (Fig. 12b). The Tattler Creek fossil tracksite is in a remote portion of the park managed as wilderness; this represents the best known and most commonly visited fossil locality in the park (Hodges and Capps, 2013). Consequently, DENA fossils are helping to illuminate both the geology and paleontology linking Alaska with Asia and the circum-Pacific landmasses during the Paleozoic and Mesozoic. The park is becoming recognized as a “paleontological frontier” by the scientific community, the media, and the public. Beginning in 2013, the National Park Service began to monitor the fossil track locality at Tattler Creek to assess natural processes and potential anthropogenic impacts. The 2018 visitor survey and the interviews of park visitors at Tattler Creek represents the first effort to evaluate visitor’s interests and attitudes involving



FIGURE 7. Isolated Cretaceous fossil dinosaur footprint exposed at Tattler Creek in the backcountry of Denali National Park and Preserve. (NPS Photo)



Figure 8. Cretaceous Denali mural depicting prehistoric life documented from localities within the park. Painting produced by artist Karen Carr. (NPS Photo)

DENA VISITOR FOSSIL SURVEY

The DENA Visitor Fossil Survey was designed as an onsite and park-based social science research project to collect important new data in the fields of paleontological resource management and protection. Specifically, the purpose of this research is to obtain visitor-use social science data that informs the DENA staff on important paleontological resource management considerations and visitor perspectives regarding park fossils. A Paleontological Resources Management Plan, a document that guides the management and protection of the valuable and non-renewable paleontological resources of the park, was finalized and implemented at DENA in 2024 (Capps et al. 2024). The visitor survey was conducted at DENA during the summer of 2018 to assess the human dimensions of paleontological resources at the park (Santucci, et al. 2016) (Appendix 2). Visitor surveys were obtained from $n = 477$ (71% response rate) visitors outside of the DENA Visitor Center during July and August 2018. The survey included five research questions presented below:

R1: What are park visitors' attitudes, interests, and motivations related to paleontological resources, both generally and specifically to DENA?

R2: Are visitors aware of DENA's paleontological resources? If so, how and where are visitors obtaining information regarding DENA's paleontological resources?

R3: What are visitors' opinions about hypothetical management actions related to paleontological resources in DENA?

R4: How do visitor demographics and trip characteristics relate to paleontological resource measures, like attitudes, interests/motivations, information, and other components measured?

R5: What are the salient qualities of visitor experience related to engagement with paleontological resources, and how do DENA's unique wilderness character qualities influence these experiences?

Surveys were collected at the Denali National Park and Preserve Visitor Center for 17 days between July 6th and August 15th, 2018 (Fig. 9). Sampling days were stratified by day, time, and location. Trained research assistants administered the sampling of visitors. During the sampling period, trained surveyors used a random number generator to choose a number between 0 and 30 that represented the time at which they would intercept their first visitor group that was either entering or exiting the sampling location. Visitors were then asked if they

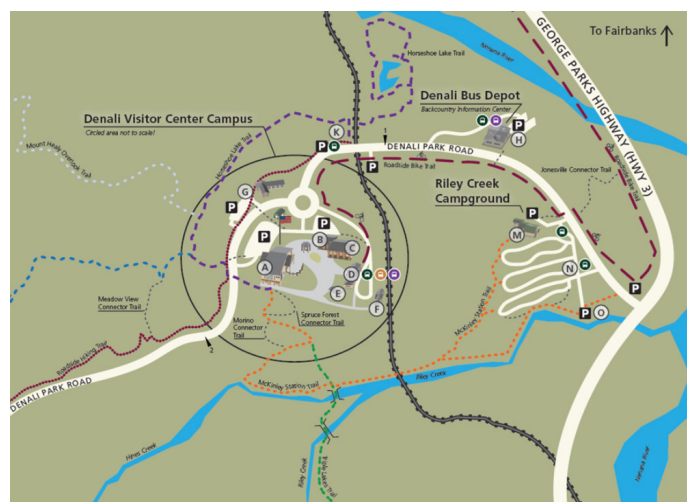


FIGURE 9. Denali National Park & Preserve entrance area map showing the Visitor Fossil Survey location at the Denali Visitor Center Campus. (NPS Map)

would be willing to participate in a survey. Visitors who were unwilling or unable to participate in the survey were asked two questions that assessed non-response bias. Visitor groups who agreed to participate in the survey were then asked who had a birthday closest to the current date. This method allowed for randomization within groups. Because of the high volume of visitors at the Denali Visitor Center, researchers would intercept every 3rd group they encountered.

DENA VISITOR FOSSIL SURVEY RESULTS AND EVALUATION

Survey Sample Characteristics

During July and August 2018, staff from Penn State University implemented two components of a social science research project involving information collection from park visitors. The first component involved a visitor survey instrument with data collection at the DENA Wilderness Access Center and the second involved interviews with visitors to Tattler Creek. The visitor interviews provided more qualitative data which is not presented in this summary.

The response rate for the visitor survey was 71% and a total of 477 ($n=477$) surveys were completed. The gender of the survey participants included 51.4% ($n=241$) females and 48.6% ($n=228$) males (Table 5). The "Family Group" was reported as the predominant group type during the survey with 60.8% ($n=285$) of participants in this category (Table 6). The participants of the survey ranged in age between 18 and 85 years old (mean = 52.2; median = 56) (Figure 10). U.S. resident or citizens represented 87.7% ($n = 413$) of the survey participants (Table 7)."

DENALI VISITOR CENTER SURVEYS

Visitor surveys were obtained from 477 visitors outside of the Denali Visitor Center during July and August 2018. The 477 total surveys obtained are based on 671 visitor intercepts yielding a 71% response rate for the survey.

Research Question #R1: What are park visitors' attitudes, interests, and motivations related to paleontological resources, both generally and specifically to Denali National Park and Preserve?

The underlying constructs (e.g. interests or motivations)

TABLE 5. DENA Visitor Survey responses to the question: "What is your gender?" (Please select one).

VISITOR RESPONSE	FREQUENCY	PERCENT
FEMALE	241	51.4%
MALE	228	48.6%
TOTAL	469	100%

TABLE 6. DENA Visitor Survey responses to the question: Group Type: "Please select the choice below that best represents your traveling party. (Please select only one choice)."

VISITOR RESPONSE	FREQUENCY	PERCENT
INDIVIDUAL	18	3.8%
FAMILY ONLY	285	60.8%
FRIENDS ONLY	66	14.1%
FAMILY & FRIENDS	51	10.9%
TOUR OR OTHER GROUP	49	10.4%
TOTAL	469	100%

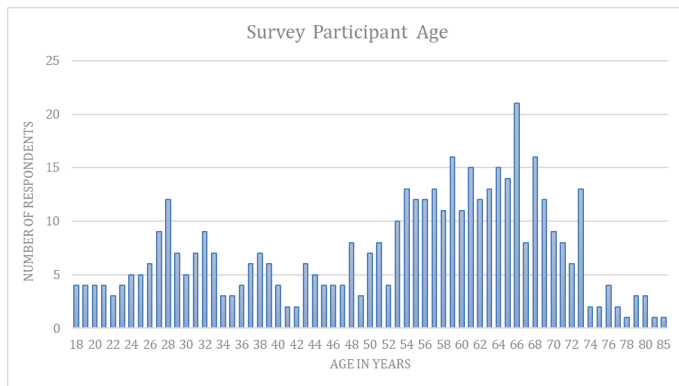


FIGURE 10. Histogram showing the distribution of DENA Visitor Survey participant ages.

TABLE 7. DENA Visitor Survey responses to the question: “Are you a permanent resident or citizen of the United States?”

VISITOR RESPONSE	FREQUENCY	PERCENT
NO	58	12.3%
YES	413	87.7%
TOTAL	471	100%

are adapted from existing literature (Fishbein and Ajzen, 2010; Santucci, Newman, Taff, 2016).

VISITOR INTEREST: Question 3 of the visitor survey focused on visitor interest in specific paleontological resource activities. A five-point Likert Scale was used which range from a response of one (1) which represents “*Not At All Interested*” to a response of five (5) “*Completely Interested*”. “*Seeing fossils preserved in rock in a natural setting*” obtained the highest mean value pertaining to visitor interest, whereas, “*Collecting fossils as a hobby*” received the lowest mean value pertaining to visitor interest (Table 8).

VISITOR MOTIVATION: “Is viewing fossils in Denali a main / large reason for your trip to the park today? (Check one)” - Yes or No. The participant responses to this question resulted in 93.6% indicated “No” (Table 9). Only 3.7% of participants responded “Yes” that “viewing fossils in Denali was a main / large reason for your trip to the park today.”

Research Question #R2: Are visitors aware of DENA’s paleontological resources? If so, how and where are visitors obtaining information regarding DENA’s paleontological resources?

R2: was also explored through the questionnaire data. In one part, we queried how aware visitors are about DENA’s paleontological resources. In a second set of questions, we evaluated the types of information sources visitors are using to get information about DENA’s paleontological resources. Analyses of the survey results are largely descriptive.

VISITOR KNOWLEDGE: Based upon the responses to the visitor survey, 59.3% of the survey participants indicated they were “*Not at all aware*” about Denali’s fossil resources (Table 10). The percentage of visitors progressively dropped with increasing awareness about Denali’s fossil resources, with only 0.8% of survey participants responding that they were “*extremely aware*” of Denali’s fossil resources (Figure 11 and Table 10).

SOURCES FOR DENALI FOSSIL INFORMATION: The visitor survey included a question seeking participant responses to the sources of information regarding Denali fossils which they obtained either prior to the park visit or after arriving at

TABLE 8. DENA Visitor Survey responses to the question: “*In general, how interested are you in the following activities*”: 1) Not at all interested; 2) Somewhat interested; 3) Very interested; 4) extremely interested; and, 5) Completely interested.

VISITOR RESPONSE	SAMPLE SIZE	MEAN
VISITING A MUSEUM OR VISITOR CENTER TO SEE FOSSILS	475	2.95
SEEING FOSSILS PRESERVED IN ROCK IN A NATURAL SETTING	475	3.37
COLLECTING FOSSILS AS A HOBBY	475	1.84
LEARNING ABOUT FOSSILS	475	2.96
ATTENDING MOVIES FEATURING DINOSAURS OR OTHER FOSSILS	475	2.76
SEARCHING FOR OR FINDING FOSSILS	475	2.64

TABLE 9. DENA Visitor Survey responses to the question: “Is viewing fossils in Denali a main / large reason for your trip to the park today? (Check one Yes or No)”

VISITOR RESPONSE	FREQUENCY	PERCENT
NO	181	96.3%
YES	7	3.7%
TOTAL	188	100%

TABLE 10. DENA Visitor Survey responses to the question: Please rate how aware you are about Denali’s fossil resources (Select one): 1) Not at all aware; 2) Somewhat aware; 3) Moderately aware; 4) Very aware; and, 5) Extremely aware.

VISITOR RESPONSE	FREQUENCY	PERCENT
NOT AT ALL AWARE	283	59.3%
SOMEWHAT AWARE	123	25.8%
MODERATELY AWARE	48	10.1%
VERY AWARE	19	4.0%
EXTREMELY AWARE	4	0.8%
TOTAL	477	100.0%

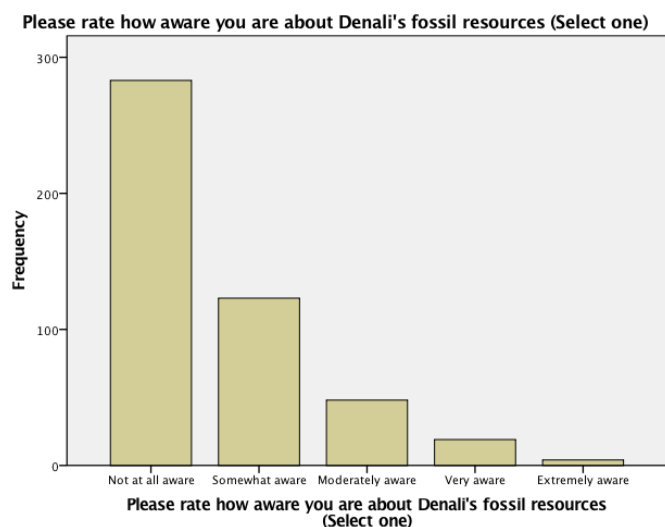


FIGURE 11. Histogram showing the distribution and frequency of responses in the DENA Visitor Survey to question where visitors rate their awareness about Denali's fossil resources.

DENA (Table 11). The responses indicate the largest sources of information about fossils obtained prior to the park visit were from two sources including "News Articles (Print or Online)" (20.1%) and "DENA Website" (20.1%). The participant responses to the survey indicate the largest source of information about DENA's fossils after arriving at park during park visits was from the "Bus Drivers" (36.4%). Given the apparent importance of the "Bus Drivers" in providing information about park resources and specifically park fossils, the park management may want to provide some guidance and training to the "Bus Drivers" to ensure accurate, consistent, and appropriate information is being shared by the "Bus Drivers" with the public. This should include information promoting resource stewardship and protection of the park's non-renewable paleontological resources.

Several observations can be made from the responses to Research Question #2. First, the survey data shows that bus drivers are an important source of information about fossils at DENA. The bus driver was identified 3 times more frequently as the source for information on DENA fossils than the park ranger. This suggests the importance of the bus driver in disseminating information on park fossils, and likely for other resources as well. Additionally, there seems to be an inverse relationship between the sources of information pre-trip and sources during trip. The numbers reflect something that is predictable given the access to sources of information. For example there would be less web access to online information and media while in park, due to its remote setting, which would typically be more accessible prior to arriving at the park. Finally, "other" sources of information on fossils are relatively high both pre-trip and during trip. It would be interesting to see the specific information that may be available from these responses.

Research Question #R3: What are visitors' opinions about hypothetical management actions related to paleontological resources in DENA?

R3: is also explored through measures on the questionnaire. Staff at DENA and the NPS have developed a series of management actions specific for paleontological resources ranging from "light-handed" indirect actions to "heavy-handed" direct actions. Visitor opinions regarding these management actions were measured on a standard Likert scale with opposition and support anchors. The results of this visitor survey may be used in future analyses to assess visitor support for management

TABLE 11. DENA Visitor Survey responses to the question: "We would like to know what sources of information you used to get information about fossil resources in Denali. We would also like to know when you obtained each type of information." (Check one Box for each item).

SOURCE OF INFORMATION ABOUT FOSSILS	BEFORE ARRIVING	AFTER ARRIVING
NPS RANGER	3.66%	12.86%
BUS DRIVER	2.44%	36.43%
OTHER EMPLOYEE	3.66%	10.71%
WORD OF MOUTH (OTHER VISITORS)	18.29%	5.0%
SOCIAL MEDIA	10.37%	0%
NEWS ARTICLE (PRINT OR ONLINE)	20.12%	3.57%
DENA WEBSITE	20.12%	1.43%
OTHER WEBSITE	6.10%	0.71%
OTHER (PLEASE SPECIFY)	15.24%	29.29%

actions related to paleontological resources.

VISITOR ATTITUDE: This portion of the survey assesses visitor opinions and attitudes regarding park management actions involving DENA fossils. A 7-point Likert Scale was used with the following question: "Please indicate the degree to which you oppose or support the following hypothetical management actions related to fossil resources in Denali." (Select one for each management action) including: 1) Completely oppose, 2) Strongly oppose, 3) Oppose, 4) Neutral, 5) Support, 6) Strongly support and 7) Completely support. Survey results are presented

TABLE 12. DENA Visitor Survey responses to the question: "Please indicate the degree to which you oppose or support the following hypothetical management actions related to fossil resources in Denali."

VISITOR RESPONSE	SAMPLE SIZE	MEAN
PROVIDE ACCESS TO FOSSIL SITES BUT ONLY THROUGH A LIMITED NUMBER OF PERMITS	473	5.09
ESTABLISH MORE EXHIBITS AND DISPLAYS IN THE VISITOR CENTER WHERE PEOPLE CAN LEARN ABOUT FOSSILS IN DENALI	469	5.72
PROVIDE INFORMATION TO VISITORS ABOUT WHEN THEY CAN HIKE TO SEE FOSSILS IN THE PARK	470	5.33
CREATE RANGER-LED TRIPS TO VIEW FOSSILS IN DENALI, BUT RESTRICT ALL OTHER VISITOR USE IN AREAS WITH FOSSILS	470	5.52
CLOSE ALL AREAS WITH FOSSILS TO THE PUBLIC	468	3.01

in Table 12.

Research Question #R4: How do visitor demographics and trip characteristics relate to paleontological resource measures, like attitudes, interests/motivations, information, and other components measured?

The survey responses related to visitor demographics at DENA are presented in tables 5, 6, and 7, and figure 10.

Research Question #R5: What are the salient qualities of visitor experience related to engagement with paleontological resources, and how do DENA's unique wilderness character qualities influence these experiences?

This portion of the visitor fossil survey was explored through semi-structured visitor interviews providing qualitative data and is only briefly described here. This portion of the research was undertaken through a phenomenological approach seeking to explain the subjective nature of experiences. This enabled researchers to be open to a variety of outcomes from the data, including outcomes that may not be previously assumed. The data from the interviews were coded into thematic elements that can be used to describe the unique qualities of viewing paleontological resources in a wilderness setting. Since the BADL visitor fossil survey did not include a qualitative component, the results of the DENA semi-structured visitor interviews will be presented in a separate research publication in the future.

DISCUSSION AND FOSSIL STEWARDSHIP ATTITUDES

Individually and jointly the BADL and DENA visitor fossil surveys provide new and useful information involving the human dimensions of paleontological resources. Although each park preserves globally significant paleontological resources, the parks each present a different historical context and geologic setting relative to their respective park fossils. BADL has been recognized as an important fossil locality for more than 175 years, whereas DENA's paleontological resources have gained scientific attention over the past three decades. Both parks preserve a significant vertebrate fossil record, primarily Eocene and Oligocene mammals at BADL and Cretaceous dinosaur footprints at DENA. From a management perspective, BADL has an unfortunate history of unauthorized fossil collecting by park visitors and commercial fossil dealers, whereas, DENA's fossil tracks have not experienced any noteworthy instances of paleontological resource crimes. At DENA, the lack of fossil resource theft and vandalism may be in part due to the resources being located in remote areas of the park and that fossil tracks are more difficult to collect and transport compared to fossil bones and teeth which are common at BADL.

An important difference between BADL and DENA, based upon the responses to the respective visitor fossil surveys, relates to the visitors' awareness and understanding about the occurrence of fossils at each park. For BADL, 86.6% of the visitors reported that they were aware that the park was an important fossil locality (Table 2). Whereas, for DENA, only 3.7% of the visitors participating in the survey reported that viewing fossils in the park was part of the reason for visiting the park (Table 9). Although the survey questions in each of the park surveys were worded differently, the significantly different responses in the questions for each park demonstrate that BADL visitors were more aware of the occurrences of fossils at that park than were the visitors to DENA.

Despite any differences that exist in the paleontological resources and their management at BADL and DENA, both parks are considered "Paleontological Crown Jewels" within the National Park Service and to the paleontological community. Both parks have active paleontological research being undertaken and have fossil-themed exhibits on display within park facilities.

BADL and DENA have each been featured in an annual National Fossil Day logo with BADL featured in the 2010 annual logo and DENA featured in the 2021 annual logo (Fig. 12a, 12b). Although the NPS has documented paleontological resources in 286 different parks, only 15 of these fossil parks have been featured in annual National Fossil Day logos, a testament to the significance of the fossils from BADL and DENA.

The visitor fossil surveys undertaken at BADL and DENA yield interesting data associated with visitor interests and their participation in fossil-related activities or experiences during their visit to each park. For the BADL study design Research Question #R6: (Recreational Choice) "What fossil related activities do visitors participate in during their visit to Badlands National Park?" and the BADL Visitor Survey questions #2 and #3 relate directly to visitor interests and their participation in fossil-related activities or experiences during the park visit. Similarly, for DENA study design Research Questions #R1: "What are park visitors' attitudes, interests, and motivations related to paleontological resources, both generally and specifically to DENA?", #R5: "What are the salient qualities of visitor experience related to engagement with paleontological resources", and DENA Visitor Survey questions #3 and #4 relate directly to visitor interests and their participation in fossil-related activities or experiences during the park visit.

Table 13 shows a comparison between visitor responses in the BADL and DENA surveys pertaining to visitor interest in fossil-related activities or experiences during their visit to each park. Although the questions in the BADL and DENA visitor survey used a different Likert Scale scoring for the questions (BADL = 7 point and DENA = 5 point) related to visitor interest in fossil related activities and experiences during their visit to the park, the respective mean scores for the responses were remarkably similar (Table 13). For both the BADL and DENA visitor surveys, "Seeing Fossils Preserved in Rock in a Natural Setting" was shown to have the highest response rate compared to all other interests in fossil related activities and experiences during their visit to the park. The mean responses for the preferences on other fossil related activities and experiences generally were similar for both the BADL and DENA visitor surveys. These two park visitor fossil surveys provide the first available data pertaining to visitor interests in fossil related activities and experiences and the similarity of responses in both surveys will be important to share with NPS staff in these two

TABLE 13. Comparison between the visitor responses by percent in the BADL and DENA surveys pertaining to visitor interest in fossil related activities or experiences during their visit to each park.

VISITOR RESPONSE	BADL	DENA
N =	639	475
SEEING FOSSILS PRESERVED IN ROCKS IN A NATURAL SETTING	81.6%	67.4%
VISITING A MUSEUM OR VISITOR CENTER TO SEE FOSSILS	73.7%	59.0%
INTEREST IN OR LEARNING ABOUT FOSSILS	72.0%	59.2%
ATTENDING MOVIES FEATURING DINOSAURS OR OTHER FOSSILS	67.3%	55.2%
COLLECTING FOSSILS AS A HOBBY	52.9%	36.8%

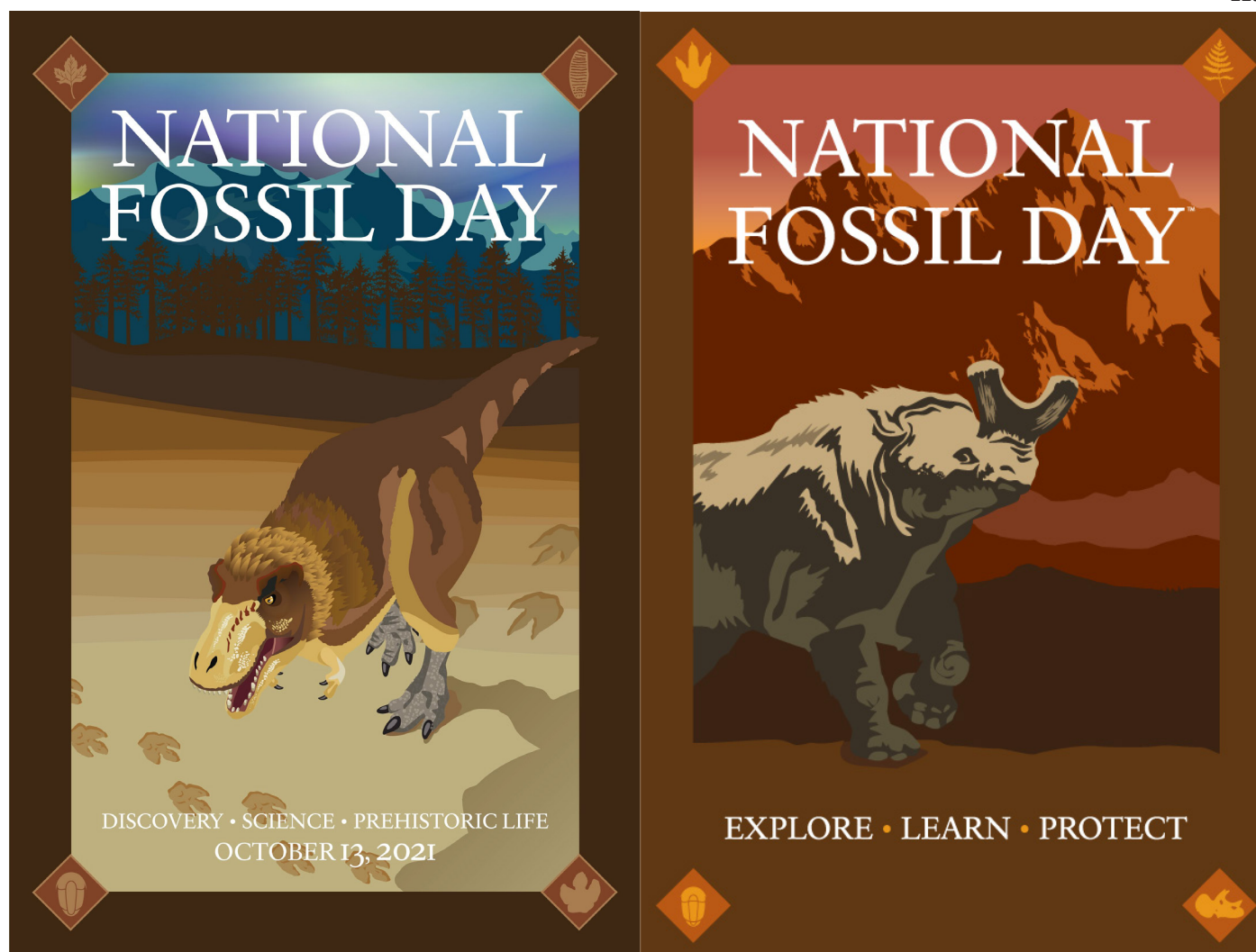


FIGURE 12. Left) 2010 annual National Fossil Day logo depicting an Eocene brontothere from Badlands National Park. Right) 2021 annual National Fossil Day logo depicting a large feathered theropod dinosaur from Denali National Park and Preserve. (NPS Photos).

parks.

Based on the visitor fossil survey responses for both BADL and DENA, park visitors are reporting their greatest interest in fossil-related activities or experiences is seeing fossils preserved in rocks in a natural setting during their visit to the park (Figure 5 and Table 8). This is extremely valuable information for park managers and interpreters to support their planning and programming at the park. Since many parks provide the opportunity to view fossils in a natural state, within a geologic context, parks provide a different experience for the public compared to seeing fossils in a museum, on social media, or in other settings (Fig. 13). Viewing and experiencing fossils by the public in a natural state (within a geologic context in rock strata) has important educational values to broaden a greater understanding of fossils, their occurrence and preservation in the geologic record, and the processes used by scientists to collect, study, and understand these non-renewable remains of life from the past. The geologic context enables the visitor to learn about and better understand the fossil's occurrence within the ancient environment in which it was preserved, along with the sediments, sedimentary features, and other organisms which are part of a collective paleoecosystem.

The experience of discovering and observing fossils in a natural setting, in a sense “in the wild”, presents park visitors

with a “cool”, memorable, and perhaps unforgettable experience during their park visit. Seeing a fossil in the wild equates to an analogy comparing the viewing a Bald Eagle in a cage in the National Zoo is one experience; however observing an eagle soaring above the Madison River in Yellowstone National Park is an entirely different experience. National parks provide park visitors the opportunity to discover, observe, and learn about fossils in a natural setting enhancing effective resource stewardship and protection messaging during these important park experiences. The survey data obtained in both the BADL and DENA studies support the current belief that providing visitors the experience of observing fossils in a natural setting (geologic context) is an important resource stewardship practice employed by NPS staff in the fossil parks.

Within the paleontological community, most paleontologists are aware that the public tends to synonymize the terms “fossil” and “dinosaur”. Whereas, there is an extensive fossil record that preserves a tremendous diversity of prehistoric life that are not dinosaurs. This includes the fossil remains of plants, invertebrates, and non-dinosaurian vertebrates. Despite a wonderfully diverse fossil record of organisms, the common interpretation of the word “fossil” by the public frequently translates to “dinosaur”, which is a widespread misunderstanding.

The BADL visitor fossil survey provides the first empirical



Figure 13. Historic photo showing the in situ exhibit of Jurassic fossils exposed for the public to view in the Douglass Quarry at Dinosaur National Monument. (NPS Photo)

data which supports the common misunderstanding and confusion that the word “fossil” does not always translate to “dinosaurs”. This is an extremely important topic to the rangers at BADL, who have recognized this visitor misunderstanding about the types of fossils preserved in the park. There are no known dinosaurs preserved at BADL however, the park preserves one of the richest and globally significant deposits of fossil mammals from the Eocene and Oligocene from anywhere on Earth. This is a scientific fact that the BADL staff and the interpretive media and exhibits in the park attempt to convey to the park visitors and address in the park’s foundation document (NPS 2017).

One other somewhat humorous factor likely contributes to the public misunderstanding about the occurrences of dinosaurs at BADL. Along Interstate 90 (I-90) near Wall, South Dakota, and the access to the western entrance (Pinnacles Entrance) of BADL, is a large sauropod dinosaur sculpture visible to travelers along the interstate (Fig. 14). We currently have no data to conclude whether the prominent display of this dinosaur sculpture has any influence over the public’s misunderstanding about the occurrence of dinosaur fossils at BADL. This question could be assessed in a future visitor survey.

The BADL visitor fossil survey is the first empirical research to report on actual data that confirms the suspicions, observations, and anecdotal perspectives of park staff that many park visitors assume when they hear there are fossils at BADL, this is often inferred by park visitors to imply dinosaurs are preserved in the park.

Finally, the data obtained through the responses obtained in the two visitor fossil surveys at BADL and DENA present both a need and opportunity to propose a new concept associated with the human dimensions of paleontological resources. As introduced in this article, we propose the concept of Fossil Stewardship Attitudes be defined as the beliefs and perspectives that individuals possess towards the resource management practices associated with fossils as expressed with some degree of favor or disfavor. The resource management practices applied to fossils by the National Park Service are derived from federal laws, regulations, and policies and based upon scientific principles and methodologies.

The data derived from the visitor fossil surveys at BADL and DENA provide important new insights to visitor perspectives towards resource management practices associated with fossils, which we propose in the concept of Fossil Stewardship Attitudes. The BADL visitor fossil survey questions #5, #7, and #8 and DENA visitor fossil survey questions #5, #6, and #7 all were designed to capture visitor responses related to paleontological resource management practices. These responses are presented



FIGURE 14. Dinosaur sculpture along Interstate 90 in Wall, South Dakota. Visitors to Badlands National Park who view this dinosaur sculpture may mistakenly conclude that the notable fossils preserved in the park include the remains of dinosaurs. (V. Santucci Photo)

in Table 4 (BADL) and Table 12 (DENA). Each of the tables presents data which would be park-specific in value and based on how these questions are presented differently in the two park visitor fossil survey. Future visitor fossil surveys should seek to present more uniform questions to gain equitable data related to Fossil Stewardship Attitudes for multi-park assessments and interpretations.

CONCLUSION AND FUTURE WORK

This visitor fossil surveys at BADL and DENA represent two of the most comprehensive research studies involving the relationships between park visitors and paleontological resources. The surveys provide new information to help park staff to better understand park visitor attitudes, perspectives, and recreational choices related to park fossils. This includes information about visitor understandings and misunderstandings pertaining to NPS paleontological resources. This information will in turn help to inform and guide future planning, programming, and stewardship activities to enhance visitor fossil-related experiences at the park and to potentially counter and redirect misunderstandings, misinformation, and inappropriate behaviors by park visitors. Finally, the visitor fossil surveys at BADL and DENA can provide baseline data to help inform future research involving fossil stewardship attitudes and the human dimensions of non-renewable paleontological resources within and outside of NPS areas.

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APPENDIX 1:
BADLANDS NATIONAL PARK – VISITOR FOSSIL SURVEY

SURVEY # _____ DATE: _____ LOCATION: _____

This survey is designed to help inform the National Park Service on visitor perspectives and experiences pertaining to fossils. Participation in this survey is totally anonymous and voluntary. Thank you for your assistance.

1. Please indicate how strongly you AGREE or DISAGREE with each of the following statements about Badlands National Park.

	Strongly Disagree		Neutral			Strongly Agree	
	1	2	3	4	5	6	7
a. The park is home to a herd of bison (buffalo)	1	2	3	4	5	6	7
b. The park has world renowned geologic formations and features	1	2	3	4	5	6	7
c. The park manages an important prairie ecosystem	1	2	3	4	5	6	7
d. The park is an important dinosaur fossil locality	1	2	3	4	5	6	7
e. The park is historically and spiritually important to Native Americans	1	2	3	4	5	6	7
f. The park represents the first national park established in the U.S.	1	2	3	4	5	6	7
g. The park preserves important fossil localities	1	2	3	4	5	6	7
h. The park scenery was primarily shaped by ice age glaciers	1	2	3	4	5	6	7

2. Please indicate whether you participated in any of the following activities during your visit to Badlands National Park.

	Yes	No	Not Sure
a. View any fossils exhibits in the Ben Reifel Visitor Center?	Yes	No	Not Sure
b. Participate in a ranger-led talk or hike which presented information about fossils?	Yes	No	Not Sure
c. See any fossils while you were hiking in the park?	Yes	No	Not Sure
d. Observe fossil preparation activities at the visitor center?	Yes	No	Not Sure
e. Collect any fossils during your visit to the park?	Yes	No	Not Sure
f. Hike the Fossil Exhibit Trail in the park?	Yes	No	Not Sure
g. Anyone in your group participate in the Junior Paleontologist Activity?	Yes	No	Not Sure
h. Purchase any fossil themed book or souvenir during your visit to the park?	Yes	No	Not Sure

3. Please rate your interests and knowledge related to fossils.

	Low		Medium			High	
	1	2	3	4	5	6	7
a. Rate your general interest in fossils.	1	2	3	4	5	6	7
b. Rate your knowledge about fossils.	1	2	3	4	5	6	7
c. Rate your knowledge about rocks and geology.	1	2	3	4	5	6	7
d. Rate your knowledge about the fossils at Badlands NP.	1	2	3	4	5	6	7
e. Rate your interest in attending a movie featuring dinosaurs or other fossils.	1	2	3	4	5	6	7
f. Rate your interest in visiting a museum to see fossils.	1	2	3	4	5	6	7
g. Rate your interest in seeing fossils preserved in rocks found at the park.	1	2	3	4	5	6	7
h. Rate your interest in participating in a fossil dig.	1	2	3	4	5	6	7
i. Rate your interest in collecting fossils as a hobby.	1	2	3	4	5	6	7

4. People value fossils for different reasons. For each of the following potential values of fossils, please rate how important you think that value is.

	Low			Medium			High	
	1	2	3	4	5	6	7	
a. Fossils have scientific value	1	2	3	4	5	6	7	
b. Fossils have educational value	1	2	3	4	5	6	7	
c. Fossils have recreational value	1	2	3	4	5	6	7	
d. Fossils have monetary or commercial value	1	2	3	4	5	6	7	
e. Fossils have spiritual value	1	2	3	4	5	6	7	
f. Fossils have aesthetic value	1	2	3	4	5	6	7	
g. Fossils have entertainment value	1	2	3	4	5	6	7	

5. Please indicate how strongly you AGREE or DISAGREE with each of the following statements.

	Strongly Disagree			Neutral			Strongly Agree	
	1	2	3	4	5	6	7	
a. Fossils are renewable resources	1	2	3	4	5	6	7	
b. Fossils are common	1	2	3	4	5	6	7	
c. Fossils are rare	1	2	3	4	5	6	7	
d. Fossils are non-renewable resources	1	2	3	4	5	6	7	
e. Fossils in national parks are protected by law	1	2	3	4	5	6	7	
f. Visitors are allowed to collect common fossils in national parks	1	2	3	4	5	6	7	
g. Visitors are not allowed to collect any fossils from national parks	1	2	3	4	5	6	7	
h. Visitors are allowed to collect rare fossils which may potentially be destroyed by erosion or other natural processes	1	2	3	4	5	6	7	
i. Educational groups are allowed to collect fossils if the fossils will be used for education of students	1	2	3	4	5	6	7	
j. Fossils can only be collected when a scientific research and collecting permit has been issued by the park	1	2	3	4	5	6	7	
k. Visitors should report the location of fossils found in the park to a park ranger	1	2	3	4	5	6	7	

6. Briefly describe any new information that you learned about fossils during your visit to Badlands National Park. _____

(PLEASE PROCEED TO THE NEXT PAGE)

7. Please rate how strongly you AGREE or DISAGREE with each of the following statements.

	Strongly Disagree		Neutral			Strongly Agree	
	1	2	3	4	5	6	7
a. Fossils are common and the removal of one or a few will not be noticed	1	2	3	4	5	6	7
b. Visitors are unaware that removing a fossil is not permitted in a national park	1	2	3	4	5	6	7
c. A rare fossil must be collected to save the scientific information it holds	1	2	3	4	5	6	7
d. If a fossil is not collected it will weather away and be destroyed	1	2	3	4	5	6	7
e. It is okay to take fossils if they will be used to train and educate others about fossils	1	2	3	4	5	6	7
f. All fossils must be collected and the National Park Service is allowing fossils to disappear	1	2	3	4	5	6	7
g. The visitor is a fossil expert and knows more about fossils than the National Park Service	1	2	3	4	5	6	7
h. If a fossil is not collected, then someone else will likely take it	1	2	3	4	5	6	7
i. Some fossils can fetch high dollar amounts on the commercial fossil market and someone may need money to support their life	1	2	3	4	5	6	7
j. It may be a family tradition to collect a fossil from a park and there is a need to continue this important family tradition	1	2	3	4	5	6	7
k. A visitor's desire to take a fossil is greater than their concern about any potential risk or penalty	1	2	3	4	5	6	7

8. Please rate how strongly you believe each statement below may influence a visitor's decision to COLLECT a fossil in a national park.

	Strongly Disagree		Neutral			Strongly Agree	
	1	2	3	4	5	6	7
a. The removal or collection of fossils by visitors is not allowed in a national park	1	2	3	4	5	6	7
b. Any collection of fossils in a national park can only occur if an approved scientific research and collecting permit is issued by the park	1	2	3	4	5	6	7
c. Fossils must be carefully excavated by a professional in order that any associated scientific information is obtained at the time the fossils are collected	1	2	3	4	5	6	7
d. The decision on whether a fossil should be collected or left in place is often based on factors to prevent negative impacts to other resources	1	2	3	4	5	6	7
e. Unauthorized fossil collecting in parks could result in a fine or other penalties	1	2	3	4	5	6	7
f. Some fossils should be preserved in the field to provide visitor's the opportunity to view and experience fossils in a natural state in parks	1	2	3	4	5	6	7
g. Not every fossil can be collected and some fossils will eventually be destroyed by natural processes	1	2	3	4	5	6	7
h. Removal or illegal collection of fossils in a national park may result in "bad luck"	1	2	3	4	5	6	7

9. Is Badlands National Park your travel destination? ☐ Yes ☐ No ☐ Not Sure

10. How many times have you previously visited Badlands National Park? _____

11. How many individuals are in your group visiting Badlands National Park (include yourself in total)? _____

12. How would you characterize the group you are traveling to Badlands National Park?

Traveling alone

- ☐ Family Group
- ☐ Friends Group
- ☐ Work Group

Educational Group

- ☐ Social Group
- ☐ Organized Tour
- ☐ Other _____

(PLEASE PROCEED TO THE NEXT PAGE)

13. What is your gender? ☐ Female ☐ Male ☐ Prefer not to respond

14. In what year were you born? _____

15. What is your home STATE (in USA) or FOREIGN COUNTRY? _____

16. What is your highest level of education completed?

- ☐ some high school
- ☐ high school graduate
- ☐ some college courses completed
- ☐ 2 year associated degree
- ☐ 4 year undergraduate degree
- ☐ Master's Degree
- ☐ Doctoral Degree or equivalent

17. Which of these categories best describes your racial identity?

- ☐ Hispanic or Latino
- ☐ American Indian or Alaskan Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or other Pacific Islander
- ☐ Caucasian
- ☐ Other

(THE END)

**APPENDIX 2:
DENALI NATIONAL PARK and PRESERVE – VISITOR FOSSIL SURVEY**

TOPIC AREA 9: KNOW10

1. Please rate how aware you are about Denali's fossil resources. (Select one)

Not at all aware	Somewhat aware	Moderately aware	Very aware	Extremely aware
1	2	3	4	5

TOPIC AREA 2: INFOSOURCE12

2. We would like to know what sources of information you used to get information about fossil resources in Denali. We would also like to know when you obtained each type of information. (Check one box for each item) **(DISPLAY LOGIC. QUESTION ONLY DISPLAYS IF VISITOR'S RESPONSE TO QUESTION 1 IS ≥2.)**

Source	Did not use	Used <u>before</u> arriving in the Denali area	Used <u>after</u> arriving to the Denali area
Personal communication with national park ranger	☐	☐	☐
Personal communication with a bus driver			
Personal communication with other employee in the Denali area	☐	☐	☐
Word of mouth (talking with other visitors or friends)	☐	☐	☐
Social media	☐	☐	☐
News article, either in print or online	☐	☐	☐
Denali National Park website	☐	☐	☐
Another website	☐	☐	☐
Please specify _____			
Other	☐	☐	☐
Please specify _____			

TOPIC AREA 9: KNOW11

3. In general, how interested are you in the following activities? (Select one for each item)

Activities	Not at all interested	Somewhat interested	Very interested	Extremely interested	Completely interested
Visiting a museum or visitor center to see fossils.	1	2	3	4	5
Seeing fossils preserved in rock in a natural setting.	1	2	3	4	5
Collecting fossils as a hobby.	1	2	3	4	5
Learning about fossils.	1	2	3	4	5
Attending movies featuring dinosaurs or other fossils.	1	2	3	4	5
Searching for or finding fossils.	1	2	3	4	5

TOPIC AREA 8: PREF5

4. Below is a list of possible experience you may prefer to have while visiting Denali. Specifically for this trip to Denali, please indicate how important the experience is to your visit. (Select one for each item)

Experience	Not at all important	Slightly important	Moderately important	Very important	Extremely important
Access to information about fossils in Denali at the visitor center.	1	2	3	4	5
Seeing fossils during hike in Denali.	1	2	3	4	5
Attending a ranger-led hike to view fossils in Denali	1	2	3	4	5
Attending a ranger interpretive talk about fossils in Denali.	1	2	3	4	5

Seeing fossils in the visitor center in Denali.	1	2	3	4	5
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TOPIC AREA 8: BELIEFS2

5. Please rate your level of agreement for each of the following statements.

Statement	Completely disagree	Strongly disagree	Disagree	Neither	Agree	Strongly agree	Completely agree
Fossils in national parks should be preserved for scientific research.	1	2	3	4	5	6	7
Parks should keep the locations of fossils confidential if damage or harm is possible.	1	2	3	4	5	6	7
Fossils in national parks should be managed for public education/interpretation.	1	2	3	4	5	6	7
Parks should take action to prevent damage to fossils.	1	2	3	4	5	6	7
Fossils in national parks should be protected from collection or theft.	1	2	3	4	5	6	7

TOPIC AREA 9: OPMGMT4

6. Please indicate the degree to which you oppose or support the following hypothetical management actions related to fossil resources in Denali. (Select one for each management action)

Management action	Completely oppose	Strongly oppose	Oppose	Neutral	Support	Strongly support	Completely support
Provide access to fossil sites but only through a limited number of permits.	1	2	3	4	5	6	7
Establish more exhibits and displays in the visitor center where people can learn about fossils in Denali.	1	2	3	4	5	6	7
Provide information to visitors about where they can hike to see fossils in the park.	1	2	3	4	5	6	7
Create ranger-led trips to view fossils in Denali, but restrict all other visitor use in areas with fossils.	1	2	3	4	5	6	7
Close all areas with fossils to public access.	1	2	3	4	5	6	7

TOPIC AREA 8: VALUES1

7. Below are statements representing different ways that people might think about nature. Please rate how much you disagree or agree in general with the statements below. Even if you don't know *or* care much, we are interested in your *opinion*. (Select one number for each statement)

Statement	Completely disagree	Strongly disagree	Disagree	Neither	Agree	Strongly agree	Completely agree
Human should manage nature so that humans benefit.	1	2	3	4	5	6	7
Nature has as much right to exist as people.	1	2	3	4	5	6	7
Nature exists primarily for people to use.	1	2	3	4	5	6	7
The need of humans should take priority over nature protection.	1	2	3	4	5	6	7
Nature is only valuable if it produces jobs and incomes for people.	1	2	3	4	5	6	7
Nature has value, whether people are present or not.	1	2	3	4	5	6	7

I view all living things as part of one big family.	1	2	3	4	5	6	7
I feel a strong emotional bond to the natural world	1	2	3	4	5	6	7

TOPIC AREA 2: TPURPOSE1

8. Is viewing fossils in Denali a main/large reason for your trip to the park today? (Check one) (DISPLAY LOGIC: QUESTION ONLY APPEARS IF ANSWER ≥ 2 FOR QUESTION 1)

☐ NO ☐ YES

TOPIC AREA 1: RES2

9. Are you a permanent resident or citizen of the United States? (Please respond "yes" or "no")

☐ NO - What is your country of origin? _____

☐ YES - What is your primary zip code _____

TOPIC AREA 1: GROUP1

10. Please select the choice below that best describes your traveling party. (Please select only one choice)

☐ Individual ☐ Family only ☐ Friends only

☐ Family plus friends ☐ Tour or other group

TOPIC AREA 1: AGE 1

11. In what year were you born? (Please respond in the blank below)

TOPIC AREA 1: GEND 1

12. What is your gender? Please select one.

☐ Female ☐ Male

"The views expressed in this article are the responsibility of the authors and do not necessarily represent the opinions or policies of the National Park Service, Bureau of Land Management, or the Department of the Interior."